

current mirror. Q_2 's high gain forces the collector current to closely approximate the emitter current which, when you apply it to R_2 , produces a measurable voltage at V_{OUT} . As with Q_1 , Q_2 needs a

maximum V_{CE} rating of $-240V$. The device in **Figure 1** is rated at $-300V$. V_{OUT} now equals $I_{OUT} \times R_2$. (The actual output current at Q_2 's collector is slightly less, because of Q_2 's base current.) At

$I_{LOAD} = 4A$, $V_{OUT} = 400 \mu A \times 10 k\Omega = 4V$. You can accommodate designs with lower or higher operating voltages by properly selecting Q_1 , Q_2 , and the base resistor, R_1 . □

Digital potentiometers enable programmable biquadratic filter

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OF THE MANY TYPES of analog filters available to designers, few allow easy adjustments of the filter parameters. The biquadratic, or biquad, filter is an exception, however. You can change that filter's corner frequency (ω_0), Q , and gain (H) by adjusting the values of three resistors. For that purpose, the lowpass biquad circuit of **Figure 1** includes three digital potentiometers configured as variable resistors in the feedback loops. Altering the settings of these potentiometers changes the filter characteristics. The circuit produces corner frequencies of 5.5 to 55 kHz; Q values of 0.055 to 5.5, depending on the selected corner frequency; and gain of 1 to 100, also depending on the selected corner frequency. To tune the biquad filter, you set a corner fre-

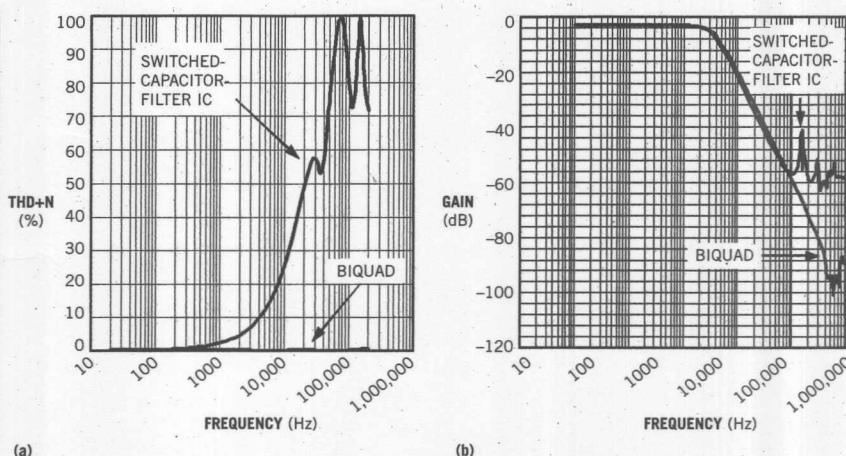
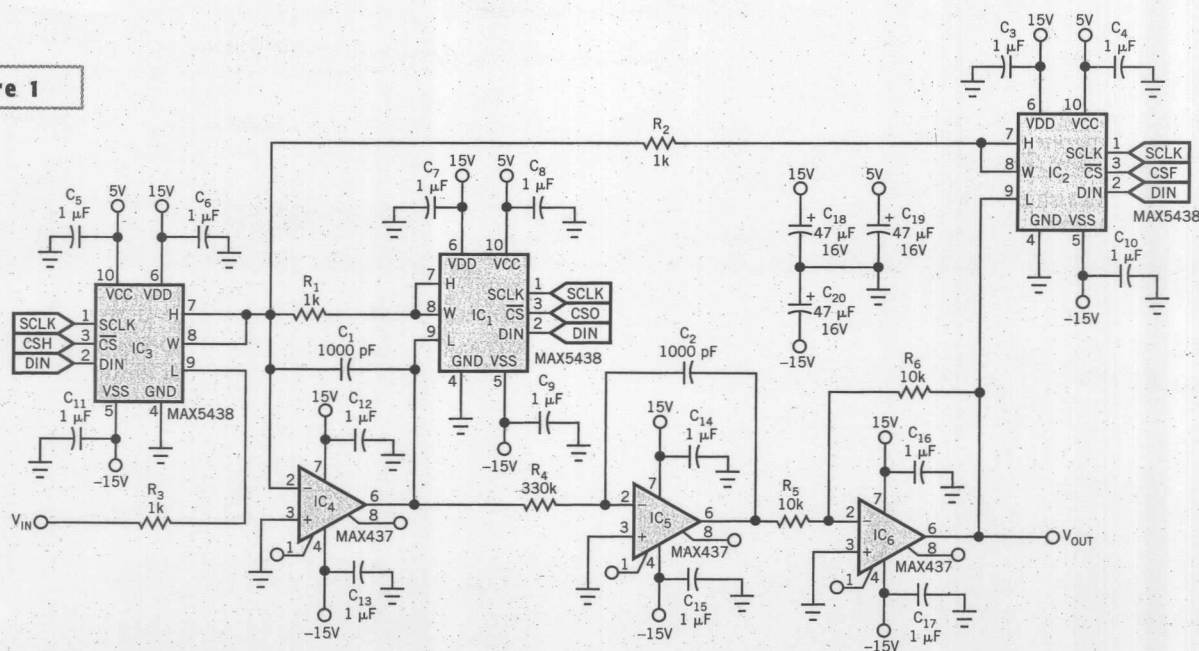


Figure 2

Noise (a) and low bandwidth (b) plague switched-capacitor filters. The biquad filter of **Figure 1** maintains less than 1% THD+N over the range 20 Hz to 200 kHz.

Figure 1



Digital potentiometers adjust the corner frequency, Q , and gain for this biquad analog filter.